DOCUMENT RESUME

ED 172 321 EA 011 645

TITLE	Energy Sources, Costs and Availability. Technical Report No. 1 of a Study of School Calendars.
INSTITUTION	New York State Education Dept., Albany. Div. of Research.
PUB DATE	Nov 78
NOTE	38p.; For related documents, see EA 011 646-651
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Costs; *Depleted Resources; Elementary Secondary Education; *Energy; *Energy Conservation; *Fuel Consumption; *Fuels; School Calendars; Utilities
IDENTIFIERS	New York

ABSTRACT

The first in a series of reports consolidates data about energy sources and extrapolates that information to the problems and expenses that New York has and will experience in heating public schools. A presentation of national energy consumption is followed by an examination of the availability of potential alternatives to petroleum and natural gas. An examination of regional energy resources and usage shows that the state of New York is well above the national average in its dependence on oil and, because of the extreme temperature ranges, the nation's pessimistic outlook on energy availability and cost is even more severe for the state. An analysis of forces and factors leading to the current situation follows. The effect of cost on energy sources is discussed and times required to complete facilities for standard sources of energy and alternative energy sources are projected. The last section of the report presents data concerning energy consumption in the school building and the effect of calendar options on total energy consumption. An extensive bibliography concludes the report. (Author/MLF)

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ENERGY SOURCES, COSTS AND AVAILABILITY

Technical Report No. 1

of

A Study of School Calendars
Conducted for the Board of Regents
of the State of New York

by

The Division of Research

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ACKNOWLEDGEMENTS

Opinions vary widely about the seriousness of our energy shortage. There will be those who, upon reading this technical report, disagree with the conclusions drawn from the data. There will be those, too, who will maintain that a certain bit of evidence has been overlooked. Yet, even detractors will be forced to admit that Jack Conway, consultant, who researched and wrote this report, has compiled an encompassing and persuasive document. Several experts in the field of energy reviewed a draft of this report and offered valuable suggestions as to its content. They were: Max Yeater, Professor of Nuclear Engineering at Rensselaer Polytechnic Institute; William Davis, Chief Energy Conservation Planner, New York State Energy Office; Norman Harrington, Director of Systems Consumer Relations, Niagara Mohawk Power Corporation; and Mrs. Shirley Anderson and her staff members, Dr. David Stricos and William Kasper of the Office of Research, Public Service Commission.

As with all the technical reports, this document was reviewed by Division of Research staff members assigned to the calendar study project. They are: Philip Pillsworth, William Alwell, and Gerald Wohlferd, Project Operations Manger.

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ENERGY SOURCES, COSTS AND AVAILABILITY FOR NEW YORK STATE SCHOOLS

NATIONAL ENERGY SOURCES AND POTENTIAL AVAILABILITY

National and New York State energy problems center around oil, which is our major source of energy. Measures to remedy the short supply of oil discuss either how to conserve it or how to develop alternatives to it. Analyses of the supply of oil arrive at the same conclusion whether considering the problem at the state, national, or world level—the supply of oil is finite. There are limits to the rate at which the available oil can be recovered. At varying estimated periods before or about the year 2000, the decreasing supply of oil will fail to meet the increasing demand. How close to the year 2000 we will arrive before the demand for energy, in spite of attempts at conservation, will exceed oil production, which is anticipated to level off and then decline, depends upon the assumptions made for different prediction models. The variance among the models is the year in which demand will exceed supply. The models also make assumptions about the price of energy. However, in none of them is an assumption made of any decline in energy costs. The predictions about the year in which demand exceeds supply vary between 1983 and 2013. These predictions establish realistic planning dates in which to accomplish the transition from our present dependence on oil to alternative sources of energy. Because of the large capital investment and the long lead times involved in developing new energy resources, the conversion effort should begin immediately. For schools, the immediate choices appear to be to conserve, retrofit, or hope that other segments of society will use the alternative sources leaving to the schools a greater share of the diminishing and expensive resource.

Availability of Oil

There are large amounts of known oil in existence, but it is not sitting in vast underground pools to be found as a gusher and to be pumped dry until the driller passes on to the next area. Oil seeps through porous rock until it is trapped by impervious rock. When a well is drilled the release in pressure resulting from the well will cause oil to flow into the well and either rise to the surface or be pumped out. This recovery through the use of natural pressure is considered "primary" production and, in the United States, recovers an average of about 25 percent of the oil in a reservoir. Secondary and tertiary methods increase the oil output from existing wells by pumping water or gas into the reservoir to increase pressure (secondary) or heating the oil, such as by steam, to lower its viscosity so that it can flow more easily (tertiary). These methods have increased recovery to 32 percent.

The supply of oil depends upon the amount of proved reserves and the rate at which the reserves can be exploited. Proved reserves are those which are both positively known and recoverable with current technology. This excludes all probable or possible sources of oil and even known sources that are technically not feasible to exploit. Even the proved reserves are not pools that can be pumped dry on demand. Such a move would be inefficient and counterproductive because it is generally impossible to produce more than ten percent of the recoverable reserves in a field in any one year without reducing the amount of oil that could ultimately be recovered. Eighty percent of the proved reserves of the world is in the Organization of Petroleum Exporting Countries (OPEC). This brings into the picture another influence on supply that was evidenced by the embargo—a conscious political decision to withhold supply and/or production. The effect of this political decision on our oil supply is well known to all of us. How and why the embargo occurred will be discussed below.

Increasing the proved reserves could be accomplished in two ways: first, by increasing production capability in the known fields; second, by exploration and discovery of new fields. The former case accounted for much of the increase in the late 1960's and, since OPEC accounts for 80 percent of the known reserves, would be important within OPEC. With improvements in recovery techniques, which could also be used domestically as part of the National Energy Plan, it has been suggested that the worldwide recovery rate could average 40 percent. The latter case could be of significance in the regions of the world which have not been explored for oil. The non-OPEC area should yield a large proportion of new discoveries. However, as the most likely areas are drilled first, the discovery rate will naturally decline further as the search moves into less promising areas. There is already evidence of this in the United States as the figures for average cost per foot of drilling for oil have increased and discoveries per well drilled have decreased. As the likelihood of finding large fields declines, the incentive for further exploration will be reduced.

As regards the supply and demand situation, although OPEC countries have the greatest amount of proved reserves, North America has the greatest production. The Arab nations account for 58 percent of OPEC proved reserves and share a usable capacity of 16.8 million barrels per day. Use of oil in the United Sates is so great that, without the OPEC imposed limitations on production, the OPEC countries of the Arabian peninsula would have just been able to meet the daily U.S. import demand before the President's energy message in April 1977. Even though the U.S. demand for imported oil was halved in the succeeding year, this potential use of the entire productive capability (production has been actually 70-75 percent of this capability) was of vital concern to the State Department because Japan, Great Britain, Germany, France, Italy, Belgium, and other nations had their own concerns and desires.

There have been estimates that the ultimate recoverable reserves may be half again as large as previously assumed for the non-Communist areas of the world. This presupposes that new discoveries, particularly in underdeveloped nations that have not been subject to intensive exploration, may be larger than previously assumed and that major breakthroughs in techniques for secondary and tertiary production will make it possible to recover substantially more oil than previously assumed. However, even these most optimistic estimates of additions to reserves would only delay for a few years the drop in production and the need for transition to other fuels. The optimistic estimate would only reduce, not obviate, the gap between supply and demand. The transition already might have been encouraged by the increased cost of oil. As it now stands, energy demands are unlikely to be able to be met by crude oil from conventional sources by the end of the century, even if the availability of oil is extended either through extensive additions to reserves or, through the increase of production limits set by OPEC members who have large reserves and limited need for current revenue(29,p.48).

National Energy Consumption

In general, our national energy situation reflects the world energy situation. In the United States oil accounted for 47 percent of energy consumption in 1977 while natural gas accounted for an additional 30 percent of the total. Overall, the 1977 national energy outlook was as shown in Table 1(30,p.32).

Table 1

Percent of Annual Energy Consumption and
Anticipated Domestic Expiration Date

Fuel	Percent Used Domestically	Anticipated Domestic Extinction Date
Petroleum	46.0	2000
Natural Gas	30.0	1990
Coal	18.0	2276
Hydro	4.0	----
Atomic	1.8	----
Misc. (wind, biomass, etc.)	0.2	----

While oil and gas make up 76 percent of our consumption, they presently compose only seven percent of our reserves. Each year, we consume an amount of oil equal to 20 percent of our proved reserves and an amount of gas equal to nine percent of the known supply(66,p.55). However, our uranium and coal reserves are hardly used. Coal constitutes 90 percent of our fossil energy reserve, but only 18.0 percent of our usage. Our known reserves in oil are not a static figure. In the period 1950-1970, we produced oil equal to 241 percent of the known reserves of 1950 and at the end of this production period our known reserves were still an amount equal to 507 percent of the 1950 known reserves(61,p.1352). However, our oil production has peaked. The Alaskan oil fields are on line with reserves of 9.6 billion barrels. However, none of this will be delivered to the East coast. Most (1/2) of the Alaskan oil is to go to California, some (1/6) to the Gulf coast. The balance (1/3), in spite of policy statements that Alaskan oil is not to be exported, reportedly will be exported with the principal importer presumed to be Japan(2,p.328). The availability of this oil would also not free any Gulf coast oil for diversion to the East coast. This is because of mandates to use American vessels, the availability of which is limited, in costal shipping and the high rates charged by such coastal shippers.

TRENDS AND POTENTIAL ALTERNATIVES

With the projections mentioned above, fuel supplies will run out by the end of the century. However, we will feel the impact in the decade of the 1980's. Because of the lead time needed for any transition, the most noticeable feature about the sources of energy in the future is the continued reliance on conventional fossil fuels. Because of new discoveries, conservation, planning and other reasons, the federal energy projections have been changed. Our usage in the country has changed drastically in the past twenty years, and we shall have to plan for changes in the next twenty. In the 1947-1975 period, coal use declined from 47.9 percent of the total energy input to about 18.9, while petroleum use increased from 34.6 percent to an estimated 46.6 percent. Natural gas showed the sharpest increase in use rising from 13.6 percent of total energy inputs in 1947 to 30.3 percent in 1974, but dropping to an estimated 28.4 percent in 1975. Hydropower rose slightly from 3.9 percent to 4.5 percent and the contribution of nuclear power was relatively small, about 1.9 percent for 1975(15,p.20). The Bureau of Mines projections noted the declining supply of domestic

natural gas and felt that supply problems for petroleum were even more acute. The Bureau predicted that by the year 2000 energy input from oil would decline to 31.3 percent and natural gas to 12.0 percent which is below their 1947 percentage contributions to total energy consumed. The decline in percentage contribution of oil and natural gas by 2000 would result as the use of existing alternatives increased and newer alternatives came on line. The coal proportion would increase to 21.3 percent while hydropower and geothermal use would also increase. By the year 2000, oil shale would come on line with a 3.5 percent contribution to energy input. Also, more significantly, nuclear power would be on line supplying 28.2 percent of the energy(15,p.32). Because of increases in demand, a percentage decrease in petroleum would occur in spite of no actual increase in production and use because of the transition to alternative sources of energy.

Following a decline in energy production, the United States' energy production then increased 4.2 percent during the period from November 1976 to November 1977. The largest production gains were found in crude oil, coal, and nuclear electric power, while the production of the other major energy resources, natural gas and hydroelectric declined—the latter due to the prolonged drought in the West. However, oil production, though constituting 29 percent of energy output, was already below the low projection for the year 2000 in spite of increased production from the Alaskan North Shore. Coal had already increased to 27 percent to exceed the high projection for the year 2000. Natural gas had increased to 36 percent, probably because of its use as a substitute fuel for oil. Nuclear power use in the one year had increased 33.7 percent to constitute 4 percent of the total energy input at least two years ahead of when it had been predicted to be such a percentage(76,p.1).

Discoveries of new resources and development of new technologies may cause changes in the future. Resources are defined as known, identified deposits from which minerals can be extracted profitably with existing technology and under present economic conditions; other mineral deposits that may eventually become available—including known deposits that are not economically or technologically recoverable at present; or those deposits that may be inferred to exist but which have not yet been discovered.

The Edison Electric Institute determined United States energy reserves and resources as shown in Table 2(18,p.137).

Table 2

United States Energy Reserves
Resources in Quadrillion BTU's

Source of Energy	Reserves	Resources
Coal	9,000	66,000
Oil	300	16,400
Natural Gas	300	6,400
Shale Oil	900	147,000
Uranium-Thermal	200	440,600
Uranium-Breeder	11,000	220,030,000
Total	21,720	220,706,400

From these figures, there is no doubt that the United States can be self-sufficient in energy. However, when considering the alternatives in terms of fiscal and social costs, the transition will be neither smooth nor rapid. Eventual self-sufficiency based upon coal, nuclear fission, fusion, and eventually solar energy is considered throughout the literature as a desired and feasible goal. However, construction and production lead time, environmental concerns, land use conflicts, and the political decision process contribute to the lags. Hopefully, the latter three would become avoidable time lags. The Edison Electric Institute additionally indicts the sluggishness of the energy industry in responding to changing conditions. The President of Sun Oil Company had indicated the same point, namely, that there is no lack of basic energy resources in oil, natural gas, coal, shale oil, and uranium in the country. For instance, coal resources are reported to be 3.2 trillion tons, of which 150 billion tons are considered recoverable with current technology. Likewise, shale oil resources are estimated at 1.7 trillion barrels, although only 54 billion barrels are judged recoverable with currently proven technology(69,p.87).

Oil

In the case of oil supply, the scarcity we feel is an imposed scarcity. Oil's share of total energy will decline, but the amounts will increase in absolute terms. With increasing demand, the differences in supply will continue to be made up by imported oil. In spite of referring to the strategic reserve storage program as part of the national energy plan, our present lack of refining capacity provides no way to effectively use such crude oil(4,p.22). Number 2 heating fuel is assumed, in the energy plan, to cost $3.00 per million BTU in 1979(42,p.50). If that figure holds true, the cost will rise to $3.50 per million BTU by 1985. Domestic demand for fuel oil dropped in 1975, but has increased each year since then. Although domestic production has increased, it has lost ground to the growing demand. As exploration for new oil increases, the footage drilled will increase, the discoveries per foot will decrease, and production costs will increase. Even without this factor, the costs would increase because both the oil industry and the President's energy policy assume that the pricing of oil is to be handled on a commodity basis, on the market value of replacing the oil rather than on the actual production costs. The world price of oil, rather than actual costs, is to be used as the standard. This disparity may be seen in the rise of Persian Gulf crude oil prices which, with production costs of twenty cents per barrel, increased from $2.591 per barrel on January 1, 1973 to $11.651 one year later. All energy prices should rise, including those of alternatives, because the standard of comparison for pricing will be oil. The problem for the schools, as consumers, is that the projections for this replacement cost are based upon the disparities between supply and demand with supply figures restricted to proved reserves. Proved reserves are those quantities of crude oil in the ground which geological and engineering data demonstrate with reasonable certainty to be recoverable from known reservoirs under existing economic and technical operating conditions(32,p.31). These are not the total discovered reserves, which include proved reserves plus probable reserves; oil potentially recoverable from existing fields in the form of extensions to the perceived size of the field or through secondary and tertiary recovery. In addition, the estimate of undiscovered reserves through geological inference or the use of other sophisticated techniques are also omitted. Incredibly, the federal government does not have its own raw data concerning oil and gas reserves. Its plans for the energy program are based solely upon the data provided by the industry, which is definitely an interested party. The American Petroleum Institute is considered the most powerful

of all the Washington lobbying interests. It is to the industry's interest to maintain proved reserves at as low a level as possible, and the Federal government is basing its plans upon this self-interest. The analogy has been made between proved reserves and a merchant's stock. The merchant keeps a minimum working inventory on hand before ordering more on the basis of the demand for his goods. Obviously, available oil falls between the extremes of proved reserves and the resource base, yet our National Energy Plan, and pricing, are based upon the low end of the extremes in supply estimates.

Gas

Estimates call for increases in the reserves of natural gas, although currently, the decline in production from known reserves is rapid and the finding rate has decreased. In 1968, the nation consumed more natural gas than it produced annually for the first time. Whereas Middle East imports have been making up the difference between supply and demand in oil, our merchant fleet does not have the natural gas carriers to do the same in natural gas. Short-term increases in production would come from already discovered reserves that would technically be old gas but would receive new prices and from production in the Gulf of Mexico. On the same basis as the earlier estimates in the national energy plan for the pricing of number 2 heating oil, it is assumed that new gas will cost $1.84 per million BTU in 1979, rising to $3.00 per million BTU by 1985. As with fuel oil, after a decrease in 1975, demand for both natural gas and liquid natural gas has increased each year since, with the disparity between supply and demand made up from imports. Compared with oil, natural gas is definitely in shorter supply. Currently, Senate members of an energy conference committee are considering phased deregulation of natural gas prices, with deregulation of newly discovered gas by 1985. At the present, the difference in price between intrastate and interstate usage is a strong incentive to keep natural gas within the intrastate market and thereby not available to those areas without adequate natural sources, such as New York State. During the 1973-75 period, only 19 percent of new gas reserve additions were made available to the interstate market, and much of that gas was from the Federal domain(21,p.ix).

Coal

The United States is 100 percent self-sufficient in coal. The United States has 363,562 million tons of reserves in place, of which 181,781 million tons are economically recoverable. Potentially, increased coal production, translated into oil equivalents, would be about three million barrels per day(32,p.67). By April 1978, one year after the President's energy message, United States' oil imports were reduced from 16 million barrels a day to 8 million. The difference would bring us well within the President's goals. However, the wildcat strikes of July and August 1976 and the UMW strike just settled would make one cautious of dependence upon such a solution. The impact of the UMW strike was mitigated by a build-up of coal stocks in anticipation of production losses associated with the strike. The real problem with coal is not its supply, but transportation, especially in the East. Extracting it from the ground with the maximum gain in net energy and the minimum damage to land and people is also a concern. The Western states have 231 billion tons of coal, most of which is low sulfur, and the homogeneity of a coal seam allows geological projection over large areas. The low sulfur coal has a lower BTU content and higher ash content resulting in its being the poorer choice for energy production when compared with high energy content Eastern coal. Conversely, high energy content Eastern coal will not

meet current environmental standards unless means are devised to reduce or obviate the resulting sulfur dioxide which, becoming sulfur trioxide upon exposure to the ultraviolet portion of sunlight, combines with water vapor in the air to form anhydrous sulfuric acid. Constituting 90 percent of our fossil fuel reserves, and with an energy equivalent equal to three times the energy contained in the Middle East's oil reserves, coal supplies only 18 percent of our energy needs. Three quarters of this demand is by electric utilities to which 88 percent of the new coal is contracted and committed until 1985. In light of the availability of this fossil fuel resource, it seems unusual that the nation depends upon its least abundant fossil fuel energy resources (oil and gas) to provide most of its energy needs.

Shale Oil and Tar Sands

Deposits of oil bearing shales extend almost all the way across the United States. It has been estimated that the oil shale deposits of Wyoming, Colorado, and Utah alone contain the equivalent of the current known world reserves of oil(58,p.153). The total potential is estimated to be several times that of Middle East oil fields(46). Currently, however, we do not have the technology, economic support, or environmental acceptability, for the removal of the oil while holding the shale in place. The federal government holds title to the most significant shale oil deposit. Earlier interest in shale oil waned in the 1920's, and from 1930 to 1974, there was a Federal oil shale lease moritorium. Two attempts to lease failed, because all bids were far below "minimum acceptable bids." But in 1974, four tracts were leased to petroleum companies in an effort to stimulate private industry to develop commercial quantities of oil from shale. This program has not been successful and all four leases have been placed on suspension. The successful bids, on the basis of estimated oil content, ranged from the equivalent of 0.38 cents to 0.74 cents per gallon at a time when the world price of crude oil was above $10 per barrel, or 24.0 cents per gallon(20,p.527). The claim has been made that shale oil extracted "in-situ" would be competitive in price with foreign crude oil, though this has not been accomplished to date. Regardless of actual production cost, the price to the consumer will be governed by the price of the viable substitute. By 1985, it is estimated that 0.3 million barrels of oil will be produced daily from oil shale. This is expected to be entirely the result of governmental action, either directly or by stimulation and subsidization of the private sector (15, p. 45). Even when a substantial rate of production is achieved, it will not supply the nation with even a notable fraction of its energy needs, but it will help supplement the nation's oil supply.

Tar sands projects are mentioned in the energy literature, but usually as an after-thought because of the lack of present technology and the expense involved in deriving an economically viable energy alternative from the low grade resource. However, studies continue on the feasibility of deriving oil from tar sands and, in 1976, there were three tar sands projects, all west of the Mississippi.

Nuclear Fuels

Nuclear fission is an attractive energy source because of the compactness of the fuel and the concentration of the energy. About three kilograms of U^{235} are capable of generating as much electricity as 2,000 railroad cars of coal(78,p.282). Figured another way, one pound of uranium has the energy potential equivalent to three million pounds of coal(20,p.15). With the use of breeder reactors, which can produce more energy than they consume, the uranium reserves can be increased by a multiple

of 130. This means that the thirty-five year reserve of naturally fissionable material can be extended to something in the vicinity of a 4500 year reserve at 1985 consumption rates. Recent support for the use of nuclear energy came from its easing the impact of the coal strike in some of the nation's hardest hit areas. This followed a year in which 16 units were canceled making 1977 an unprecedented year for nuclear project cancellations. At present there are 70 operating commerical nuclear electrical generators. Use of breeder reactors would obviate any reliance on foreign ore. Of our domestic supplies, more than 90 percent of the high grade uranium ore reserves are in the Colorado Plateau and the Wyoming Basins, with another 8 percent in the Northern Rockies. From 1963 through 1974, Wyoming and New Mexico each produced as much ore as all the other locations. The two states can be expected to continue as primary production centers in the future. All of the producing uranium ore sites are West of the Mississippi, indicating that the industry has not yet seriously considered the development of eastern sources of the mineral.

The other source of nuclear energy is fusion. The magnitude of the energy released when the nuclei of two atoms are fused is very great. The nucleus which undergoes fusion at the lowest temperature is deuterium. On a weight basis, deuterium fusion produces approximately three times as much energy as the fission of U^{235} with no net production of radioactive products. Neutrons produced have a short lifetime and pose no hazard beyond the immediate vicinity of a reactor. The major disadvantage of fusion is that the technology for carrying out controlled fusion is not now available. Therefore, commercial scale installation will not be possible for many years hence.

Solar Energy

Solar energy is considered the cleanest and most abundant source of energy. By 1980, the Energy Research and Development Administration (ERDA)* says solar power could be competitive with all fuels, because its costs will be cut in half. For large scale use, the process is capital intensive and has technical, economic, and institutional barriers to immediate and widespread use. A ten megawatt solar electric generating plant is being built in Southern California with the first electricity from the plant hoped for in 1981. ERDA predicts that solar energy will cover 7 percent of the nation's energy needs by 2000 and 25 percent by 2020. The heating and cooling of residences and commercial and public buildings by solar energy is technically feasible. In one year after the President's energy message, the number of solar heated homes in the United States increased from 10,000 to 40,000.

Hydroelectric Power

Hydroelectric power provides about 10 percent of the nation's electricity. Many of the locations that are most suitable for hydroelectric plants are already in use. Therefore, only a modest increase in hydroelectric capacity is expected during the remainder of the century, resulting in a declining percentage of the contribution of hydroelectricity to the total energy supply.

* ERDA was established by Public Law 93-438, the Energy Reorganization Act of 1974. It assumes the energy research and development functions of the abolished Atomic Energy Commission. ERDA is responsible for the research, development and demonstration of various forms of energy including fossil fuel programs, underground electric power transmission research, helium applications study, solar heating and cooling development, geothermal power development, and alternative automotive power systems. The agency is composed of parts of the defunct Atomic Energy Commission and the Department of the Interior (including the Bureau of Coal Research), portions of the National Science Foundation and the Environmental Protection Agency.

Synthetic Natural Gas

Synthetic natural gas (SNG) is included in the President's energy plan. SNG was manufactured in the winter of 1976-77 at a cost of between $4.50 and $5.25 per thousand cubic feet or the equivalent of about $30 for a barrel of oil. As it becomes increasingly difficult to satisfy the demand for gaseous fuels with natural gas, there will be a return to SNG. There is not expected to be any significant production prior to 1980 and most of the production of that year will be oil based. By 1985, coal gasification is projected to produce 380 billion cubic feet of gas per year and consume 26 million tons of coal. A low priority is placed on petroleum based SNG because of objections to using petroleum imports for this purpose. In the period 1985 to 2000, petroleum inputs to SNG are expected to disappear and the output of coal gasification plants will increase twelvefold to 4,670 billion cubic feet as coal input increases to 300 million tons. The preference for SNG over liquid natural gas (LNG) is apparent when, among other reasons, one recalls the earlier reference to the lack of LNG carrying capacity of our merchant marine.

Geothermal Power

The only operating geothermal electric power facility in the United States is in Sonoma County, California, about 80 miles north of San Francisco. It is operated by Pacific Gas and Electric, and is called the Geysers. It is the largest such facility in the world and generates 502 megawatts of electricity with a potential of 2,000 megawatts, but it only provides 1¼ percent of California's needs. San Diego Gas & Electric Company hopes to be generating electricity as the nation's second producer of power from geothermal energy by the 1980's. Almost all of the known geothermal sites are in the Western states.

Biomass and others

Other options are biomass and the use of both winds and tides. Biomass is the direct use, liquification, or gassification of agricultural and forestry residues. Since the concept derives ultimately from the use of growing vegetation, it has the advantage of being a constantly renewable source. Winds and tides are inexhaustibe but have two disadvantages: first, the requirement of a large capital investment, and second, inadequate storage means. The first disadvantage involves the capital investment required to develop and build the number of windmills, necessary for widespread use of the winds and the cost of the tidal power dams necessary for use of the tides as a source of energy. The second disadvantage involves the non-continuous nature of both winds and tides. In most areas, the present means of storing energy are inadequate to guarantee the storage of sufficient energy from the flow of wind and water to cover the becalmed periods resulting from the vagaries of the wind or neap tide. Two of the world's largest windmills are being built at Valley Forge as government backed experiments. The only installation of tidal power in the world today is in France. The only promising location in the United States is at Passamaquoddy Bay in Maine, a project that has been a subject of controversy since its proposal during the New Deal over 40 years ago. However, with the scarcity of energy resources in northern New England, its 2 billion KHW per year potential makes it a more attractive project.

REGIONAL ENERGY RESOURCES AND USAGE

The significance of the pricing and supply of oil for New York State becomes more apparent when we go from the national level to the regional level. New York is contiguous to the New England region and the Northern states of the Middle Atlantic Region, so its characteristics generally fall between the two regions. This is mentioned because aggregated regional data, rather than state level data, is often presented in articles of interest to school officials. The comparison of the energy sources by gross consumption in 1974 was as shown in Table 3(14,p.19;37,p.15).

Table 3

Comparison of Energy Consumption in 1974

Energy Source	U.S.	New England	New York State	Middle Atlantic
Coal	17.8%	1.9%	9.0%	21.9%
Petroleum	46.1	81.0	64.4	55.0
Natural Gas	29.9	9.4	16.2	17.1
Hydro Power	4.5	1.3	7.9	3.5
Nuclear Power	1.7	6.4	2.5	2.2

All three regions are well above the national average in dependence on petroleum. For the total region, 80.8 percent of the residual fuel is imported as compared with a national average of 50.2 percent(43,p.127). The Federal Energy Administration estimates that by 1980, we should still be importing at the same levels. During 1975, New England used 1387 million barrels of residual oil. Almost 93 million of these barrels came from refineries in the Caribbean. Although most of the crude originated in Venezuela, almost 19 million of those barrels came from crude oil which originated in the Middle East, making this relative amount of residual fuel oil vulnerable to an embargo by the same Organization of Arab Petroleum Exporting Countries (OAPEC) that imposed the oil embargo during 1973-74. In 1976, 68.2 percent of the crude oil imports to Petroleum Administration for Defense (PAD) District 1, of which New York State is a part, came from these same embargo nations. This 68.2 percent figure excludes crude shipped to the Virgin Islands, refined, and then transshipped to the U.S. Therefore, the regional dependence on the embargo nations for crude oil and petroleum products is actually higher than the percentages would indicate. Furthermore, the household/commercial sector, the category under which schools are subsumed, is the second largest user of petroleum products and the leading user of natural gas in the Middle Atlantic region.

NEW YORK STATE ENERGY RESOURCES AND USAGE (56)

Because of extreme weather conditions and a large population, New York State is the fourth largest energy user among all the states and requires more petroleum products than any other. However, the energy supplies available within New York's borders are only adequate to satisfy 10 percent of this demand.

Natural Gas

New York State's per capita natural gas consumption is about one-third that of the nation. However, the residential and commercial sectors which are the highest priority end-users, account for about 80 percent of the State's natural gas consumption, far exceeding the 36 percent national average. The residential sector alone accounts for three-fifths of the State's consumption compared with one-quarter for the nation. The twenty-one gas utilities in New York State receive approximately 95 percent of their total gas supply from nine interstate pipeline transmission companies. All of these pipelines are regulated by the Federal Energy Regulatory Commission. Under the Emergency Natural Gas Act of 1977, the federal government has the authority to order emergency transfer of gas among interstate pipelines in order to protect high priority customers. Upon certification by a pipeline that curtailment of residential, small commerical, or human needs customers is imminent on its entire system, such transfers may be ordered, provided that the order will not create high-priority shortages for the delivering pipeline.

The remainder of the gas available to New York State is supplied from instate gas wells, synthetic gas plants, imported liquified natural gas and propane facilities.

Petroleum

Petroleum products account for 65.2 percent of total State energy consumption, far above the national average.

The peaks and valleys in the State's petroleum product demand coincide with the seasonal requirements for residual and middle distillate oils used as space heating fuels. Petroleum is needed in largest quantities during the first quarter of the year. Demand then shifts rapidly, reaching its low point in the third quarter.

The State's petroleum requirement is satisfied almost totally from sources located beyond its borders. Roughly one million barrels of crude oil are produced annually within the State. For the most part, this oil is refined in Pennsylvania, primarily into lubricating oil. Approximately 60 percent of the finished petroleum products consumed in the State are obtained from domestic refineries. The remaining 40 percent are imported directly from foreign sources, predominantly the Caribbean, Virgin Islands and Venezuela. This can be compared with a figure of 15 percent for the nation as a whole.

In 1975, the composite U. S. refinery crude oil mix was 67 percent domestic and 33 percent foreign. By 1976, imported crude rose to 39 percent of total refinery crude requirements. While complete 1976 data are unavailable, the 1975 crude oil ratio, coupled with the State's refined petroleum demand pattern, resulted in foreign crude accounting for 60 percent of all finished products consumed in New York State.

Arab nations in the Persian Gulf and North Africa supply the single largest share of the imported crude (over 32 percent) processed in domestic refineries. Moreover, these Arab nations supply crude oil to the foreign refineries, aside from Venezuela, on which New York State is dependent for finished product. Consequently, 16 percent of the refined petroleum consumed in New York State is derived from Arab crude processed either domestically or abroad.

Venezuela, while a member of OPEC, has historically been the largest individual exporter of refined petroleum to the United States. In addition, it has provided vast quantities of crude oil to our domestic refineries. However, in recent years, shipments of Venezuelaen crude oil have declined. Including the Venezuelan crude that is processed in Caribbean refineries, 14 percent of the State's petroleum product requirement originates in Venezuela. Arab and Venezuelan crude together supply three out of every 10 barrels of petroleum products consumed in the State.

Only two refineries are in operation in New York State, both located in Erie County. The crude oil mix at the two refineries is 45 percent domestic and 55 percent foreign, forty percent of the latter is from Arab nations. Traditionally, these refineries relied solely on Canadian crude oil. However, Canada intends to phase out exports of all crude oil by 1981. As a result, the Erie County refineries are in the process of shifting completely to crude from other sources.

Home Heating Oil—Middle Distillates

Middle distillates (number 1 and heating oils) are the petroleum products that show the widest seasonal demand variations. Because middle distillates are consumed principally as space heating fuels, demand is extremely sensitive to the weather. In New York, peak demand occurs during the first quarter and exceeds third quarter usage by more than a factor of three. In severe winter weather, middle distillates will have to be stretched to meet traditional winter demand and to fill in as an alternate fuel for curtailed natural gas needs in industry, hospitals, schools and government buildings. New York State's 1975 consumption of middle distillates (excluding diesel fuel), broken down by percentages of use per calendar quarter, is as in Table 4(56,p.14).

Table 4

New York State Quarterly Consumption
of Middle Distillates
1975

Calendar Quarter	Percent
1st	44.0
2nd	21.1
3rd	9.5
4th	25.4
Total	100

Domestic refineries satisfy the largest share of the State's middle distillate requirements. Twenty percent of the need is obtained from foreign imports; however, of this amount, the Caribbean refineries coupled with Puerto Rico and the Virgin Islands account for 12 percent. Direct imports from Arab countries are minimal, but crude from these nations accounts for 12 percent of the State's distillate demand.

Coal

The bulk of New York State soft coal requirements are filled from sources which originate in the Appalachian Basin, primarily West Virginia, while hard coal supplies originate in Pennsylvania. Most bituminous coal consumption occurs in western New York.

In 1975, soft and hard coal supplied approximately 7 percent of the State's total energy requirements. Anthracite coal accounted for only 4 percent of total coal consumption in New York. Aside from Pennsylvania, New York consumes more anthracite coal than any other state.

Though the majority of coal consumed in New York is purchased from producing companies in the Appalachian Basin, limited quanitites of low-sulfur coal for electrical generation are purchased in the western United States. Large industrial users and utilities purchase coal directly from producing companies.

Ninety percent of bituminous coal is moved by rail and the remaining 10 percent by truck and barge. Seventy percent of anthracite coal is moved by truck and 30 percent by rail. Large portions of the rail system in New York State are unusable. Consequently, complex planning would be required to redirect emergency coal shipments around damaged portions of track. Additionally, shortage of available rail coal cars and the resulting postponements in forming unit trains, often delay delivery of bulk supplies to large coal consumers. Increasing coal availability in the State will likely require the cooperation of the federal government and industry.

Furthermore, coal supplies of one user generally cannot be used by another. Steel and coke making demand bituminous coal; these industries cannot use the lower grade utility bituminous coal. Equipment burning anthracite coal is constructed to operate with a specific size of coal. Shortages of the large size anthracite coals used mainly in residential and small commercial buildings cannot be offset with supplies of small anthracite. Further, trucks are required to obtain I.C.C. licenses to carry coal in interstate commerce. This would affect counties in New York State that particularly rely upon Pennsylvanian resources. Consequently, actions designed to eliminate a coal shortage often require a determination of available trucks and/or provide for waiver of licensing requirements.

Electricity

New York State electric companies are dependent on fuel imports for almost 100 percent of their non-hydro requirements. Recognizing that there may be differences in the factors for electricity and natural gas prices, future expenses for the school districts may be estimated by the figures in Table 5 of 1985 energy prices per million BTU's in constant 1975 dollars, for the commercial sector. The figures are for the Federal Energy Administration (FEA) Region 2, of which New York State is a part.

Ninety percent of New York State's residual oil (Nos. 4, 5, 6, Bunker C and Navy Special) is imported; the balance originates from East Coast and Gulf Coast refineries. New York's imported residual oil is obtained primarily from the Virgin Islands, Venezuela and from five refineries in the Caribbean (Aruba, Curacao, Bahamas and Trinidad (2)). Lesser amounts are received from Europe and Africa. During 1975, residual fuel accounted for 24.2 percent of the State's total energy consumption.

Table 5

FEA Region 2 Energy Prices Per Million BTU
Expressed in Constant 1975 Dollars, Commercial Sector

Energy Source	Base Cost	With Implementation of President's Energy Plan
Electricity	$14.97	$15.64
Natural Gas	2.99	2.75
Distillate, Fuel Oil	3.12	3.31
Residual, Fuel Oil	2.59	2.66

In the downstate area, imported residual oil is the fuel used for over 75 percent of the power generation. The New York State electric utilities have had a massive switch from coal-burning stations to oil-burning and nuclear power. However, the electric utility sector still accounts for 50 percent of the State's coal consumption. Comparing this with the 66 percent national figures reflects the State's greater dependence upon oil as a generation fuel. Except for plants in Western New York, all coal-fired plants in the State have been converted to oil. The utilities have also been required to burn oil of lower sulfur content, especially in the New York City area. The problem with converting to coal is, among other things, that low sulfur coal is found mostly in the West with concomitant transportation expenses. Also, most of the low sulfur coal found in the East is controlled by or committed to the steel industry under either ownership or long-term lease. High sulfur coal, which is abundant in the East, is not only less expensive, its use would reduce overall transportation expenses, and produce more energy than Western low sulfur coal. However, the drawback is that it cannot be used in many existing utility boilers. Niagara Mohawk, along with the other New York State utilities, is conducting a demonstration research project, near Buffalo, to burn Eastern coal without producing a sulfur-bearing sludge.

The transition to and dependence on oil in New York State for utilities can be seen in the percentage of energy by primary fuel sources as shown in Table 6(39,p.6).

Table 6

Percentage Comparison of Energy Sources for
New York State Utilities by Percent of BTU's 1965-1976

Energy Source	Year	
	1965	1976
Coal	61.52%	20.92%
Gas	13.24	00.67
Oil	23.88	66.65
Nuclear	01.45	11.76

These figures are a result of calculating the BTU's per type of fuel and then expressing the result as a percentage of total BTU's. Essentially, coal and oil have switched places in their contribution to energy supply in the State. Even these figures are skewed, however, since Con Edison, Long Island Lighting, Central Hudson Gas and Electricity, and Orange and Rockland Utilities use no coal, while New York State Electric and Gas relies 100 percent upon coal. For the total energy consumption in the State, by primary input, the comparable figures are as shown in Table 7(36,p.10;38,p.4).

Table 7

Percentage Comparison of Total New York State Energy Consumption by Percent of BTU's 1965-1974

Energy Source	Year 1965	1974
Coal	21.1%	09.1%
Natural Gas	15.7	16.3
Petroleum	57.1	64.1
Hydro and Nuclear	6.1	10.5

Approximately 30 percent of the total primary energy consumed in New York is consumed in generating electricity, which, in turn, supplies approximately 9 percent of final end-use consumption.

The amount and type of fuel used by the New York utilities in the generation of electricity is not typical of the national average. The 1977 energy requirements for electric generation were projected to be substantially above national averages for oil (primarily residual) and hydro, while considerably below national averages for coal and natural gas. The projections are as shown in Table 8(56,p.34).

Utilities account for over 50 percent of total residual oil consumption. Therefore, residual fuel oil demand is heavily dependent on variables influencing this sector. Additionally, coal availability affects residual oil demand. A coal strike or any other disruption in coal supply (river freezeups, transportation strikes, mine disasters, shortages of rail hopper cars) may increase residual fuel demand. Approximately 17 percent of the total electric requirements in this State are produced by burning coal.

Stockpiles would allow the utilitites to sustain energy production for at least the first 60 days of a coal strike without much difficulty. Beyond that time, utilitites may have to transfer generating load to units capable of using residual oil as an alternate fuel.

If natural gas were to be curtailed, residual fuel would be affected for space heating and industrial process uses. Residual fuel is one of the primary alternate fuels for curtailed natural gas users.

Table 8

Comparative 1977 New York State and United States
Energy Requirements for Electric Generation
Percent Distribution by Energy Source

Energy Source	New York State Power Pool**	United States
Nuclear	17%	13%
Coal	17	47
Oil	44	17
Hydro	22	11
Natural Gas	0	12

** The New York Power Pool (NYPP) was established in 1966 to, among other things, achieve optimum coordination in the planning and operation of the statewide electric system, during both normal and emergency conditions. The member companies of the NYPP form part of the Northeast Power Coordinating Council which also includes Ontario, New Brunswick, and New England. This regional Council is in turn part of the National Electric Reliability Council.

Petroleum Product Distribution

Large volumes of petroleum products are delivered by "over the road" vehicles and barges. Weather conditions are an important variable in this part of the petroleum product distribution system. Northern counties are forced, by the prospect of river freezeups, canal closings, and blocked roadways caused by severe winter weather, to store their entire seasonal supply by the end of November. Inclement weather, as occurred in the western portion of the State in the 1976-77 winter season, can all but halt truck movement of oil supplies. Waterway freezeups were experienced in 1976 and 1977 and caused long delays in shipping oil over rivers, lakes and coastal inlets. These constraints are of special concern to residual fuel users since the fuels are not transported by alternative methods such as pipelines. No product pipelines extend north of Brewerton, which is just above Syracuse. Decisions to reallocate refined oil across the State would therefore be accompanied by directives to clear or open highways and to break up ice jams on waterways.

New York State Options

New York State is one of highest fuel-cost areas in the nation. The cost per unit of energy for New York State is consistently among the highest in the nation. Although among the states having the highest expenditures for energy in the nation, our per capita consumption of energy is substantially below the national average.

The Governor's special message on energy on February 8, 1978 indicated that national oil pricing and supply problems would continue to dominate the State's overall energy situation. Even with successful diversification efforts, for the foreseeable future, petroleum products will continue to account for the bulk of the State's energy consumption. The Atlantic Outer Continental Shelf, when tapped, could supply up to 5

percent of the State's oil consumption and 28 percent of the State's gas consumption for twenty years. An additional 2 percent of the State's natural gas requirements could be met through production of the natural gas reserves under the New York waters of Lake Erie. The Governor gave the Energy Office the prime responsibility for statewide planning as regards indigenous energy resources, including: Lake Erie natural gas, on-shore gas and oil, Atlantic off-shore oil, natural gas from Devonian shale formations, small head hydro-electric generation, wood, solar energy for hot water and space heating, fuel cells, solid waste, energy from biomass, cogeneration (the simultaneous production of industrial process steam and electricity), and wind. Feasibility studies are to be conducted on coal gasification and also of retro-fitting oil fired utility or industrial boilers to use this gas.

To help ease the New York situation, the U. S. Department of Interior has listed in its survey of projects to expand fuel sources: a synthetic natural gas project using naphtha to produce 125 million cubic feet per day commencing in 1979; one refinery with a capacity of 200,000 barrels per day commencing in 1979; and twenty-nine electric generating plants of which three are oil, seventeen nuclear, four coal, three hydroelectric, one solid waste, and one gas powered. Solar energy projects are exemplified by the 7,500 square foot SUNY Albany Alumni House and Conference Center. During 1978, New York utility companies will provide $54 million in support of research on new energy techniques. In addition to supporting 30 solar studies, they are directly involved in about 400 projects devoted to such items as: fuel cells, energy storage systems, advanced fossil and nuclear generating options, assessment of environmental problems associated with energy production, and means of mitigating environmental impacts.

However, as indicated, because of the area's dependence upon oil, which is well above that of the national average and because of our extreme temperature ranges, the nation's pessimistic outlook on energy availability and cost is even more severe for New York State. New York State is well above the nation's average in costs, and, depending on the outcome of the National Energy Plan, will probably remain well above the nation's average as costs increase. Currently, new oil, which is controlled at $11.28 per barrel, would be allowed to rise, under the President's energy plan, to the world price of $13.50 per barrel, reflecting, as mentioned earlier, the Federal government's acceptance of pricing based on the cost of replacement rather than cost of production.

FORCES AND FACTORS LEADING TO THE CURRENT SITUATION

With these projected costs of energy, the question would arise as to how our State and Nation came to be in such a position. In the market for oil, a deliberate policy of surplus was initiated. Since oil is in underground reservoirs, it is difficult to define and enforce property rights when a field is owned jointly. Because of the rule of capture, each of two competitors would attempt to drain a common pool before the other. Violent fluctuations arose in the price of crude oil as developed fields were intensely mined and new discoveries made. In order to cope with this problem, the State regulatory agencies developed the demand pro-rationing system, which set total production targets for the State and distributed production quotas according to a formula which favored small and usually high cost producers. Prior to 1948, the United States was a net exporter of oil, holding 31 percent of the then proven world reserves. However, accelerated discovery and development of low cost reserves in the Middle East began to make inroads into the U. S. position.

Threatened by the competition from low-cost foreign oil imported mainly by the U. S. based major integrated international oil companies who had made the discoveries and developments, other domestic producers and refiners succeeded in persuading the government to institute a voluntary oil import program in 1957. This program failed (imports to the U. S. actually increased) as other non-major producers attempted to import from their newly developed wells in the Persian Gulf area. So, under pressure of domestic producers and refiners who demanded protection from cheap foreign oil on "security of supply" and other grounds, the voluntary system became a mandatory import quota system in 1959.

The quota system lasted until April 1973, insulating a segment of our domestic oil industry from the competition of the market place. The imposition of the quota, based on a fixed share of the U. S. oil market, meant that imports could grow only at the rate of growth of U. S. production. The increased production coming on line from foreign wells developed by non-major U. S. producers had to be diverted from the U. S. market. Precipitous price declines occurred in the world oil market and price competition forced the majors to match the decline. As they cut prices in order to lighten the squeeze on profits, the majors unilaterally cut posted prices rather than the market price. With their lack of response to the exporting nations' strenuous protests and explicit warnings, OPEC was formed.

The surplus policy on domestic oil, pursued by both State and Federal authorities at the instigation of some segments of the industry, reduced incentive to improve efficiency and to add to the stock of oil reserves. Another blow was delivered to the oil market with the series of price freeze and control programs instituted in 1971 to fight inflation. This held down the price of domestic oil as the price of foreign oil increased and surpassed the U. S. level, making the import quota system moot. The Cost of Living Council then adopted a policy of a two-tier price system, with a ceiling on old crude to prevent windfall profits and a market determined price on new crude in order to encourage domestic exploration and development.

When the OAPEC placed the U. S. under embargo as a direct result of the American decision to supply arms to Israel on a major scale, the U. S. energy markets were tied up in knots due to the effects of past policies, such as demand pro-rationing, mandatory import quotas, and price controls on oil and natural gas. The U. S. dependence on foreign oil was to become larger than that which would have resulted from open world markets for natural gas and oil. The overlap of the embargo with the quadrupling of prices by OPEC as a whole, added a price crisis to the boycott crisis. Having seen the effect of the boycott, and after years of being told what they would be granted, the exporting nations were now calling the shots. With little or no government guidance, the oil companies assumed an every man for himself attitude and the consumer paid the bill.

The earlier low price of oil and the controls on the wellhead price of natural gas in the 1960's, combined with the Supreme Court decision of 1954 which directed that interstate producers should charge only a "fair and reasonable" price and which also empowered the Federal Power Commission (FPC) to oversee interstate gas prices, compounded the problem. The FPC regulated price on a case-by-case basis, but developed such a backlog that in 1960 they established an area wide price. The lower

prices in a market economy produced the anticipated effects. The consumer converted from coal to the less expensive fuels—gas and oil. Producers stopped searching, in response to lower prices and less expensive foreign sources, but production did not start decreasing until 1973, thereby masking the effect of pricing until it was highlighted, by coincidence, by the effects of the reductions in production hitting the consumer at the same time as the embargo.

CONCLUSIONS FOR ABATEMENTS IN PRICE OF FUELS

In light of the above, there is no hope for abatement of prices. Any true reduction for the ultimate consumer would be in the form of rebates or tax credits to the private individual and even that seems more and more remote. We will be a captive market in an expensive market place because of such factors as:

- o The oil industry seeking pricing on the basis of replacement cost rather than production cost
- o Federal policy reflecting the above attitude
- o The pricing of alternatives based on the pricing of oil
- o More and more of the alternative market being bought into by the oil companies
- o Pass through of fuel expenses by the utilities offering no inducement for efficiency
- o Consideration of $3 per barrel import fees, deregulation of domestic crude prices, and $2 per barrel tax on imported and domestic crude
- o Production and exploration costs of gas and oil increasing; and the lead time required to retrofit our facilities to use alternatives plus the lead time to develop alternatives.

Saudi Arabia, which is in the best position to break the oil cartel because the pricing already provides a cash flow well in excess of any anticipated national needs, is pro-U.S., but has compromised on limiting price increases rather than pushing for reductions. If fuel costs were to be reduced, such as the fall of world prices to $8 per barrel or the regulation of domestic prices over a long period, the Federal Energy Administration reports that production is never likely to be much above today's levels and would decline again(27,p.9). In order to obtain enough oil and enough natural gas, the expenditure of increasingly greater sums will be required. However, the American public does not buy energy per se. The inelasticity in the price of energy that appears in the literature reflects what the public is willing to pay for what the use of energy buys—convenience and comfort. If that is the cost, then it is worthwhile looking into alternative means of providing our comfort and convenience. Besides cost, availability would be another inducement for seeking alternatives. In the event of another embargo, there is no guarantee that oil destined for the U.S. will reach this country because oil companies, including U.S. companies, would probably do as they did during the 1973-74 embargo and act as oil managers. During that crisis, the oil companies chose to supply Japan more generously than they did the United States or Western Europe. Later, domestic development was stimulated in Japan and the Japanese government established "administered" prices for oil products. These prices could not be sustained and prices for some products,such as gasoline, actually fell under the pressure of market competition(47,p.49). The Industrial Bank of Japan is concerned about a two-tier pricing system in Japan, because they see the beneficiary as the local affiliates of the major American oil companies.

Effect of Cost on Alternatives

Federal statements, and those of the Director of the Congressional Budget Office, give every reason to believe that the U.S. self-sufficiency price of oil will be the world price. This becomes circular as the OPEC nations have commissioned private studies to determine what the cost of substitutes for crude oil might be. It is in their best interest to price oil so that such alternatives, essential for U.S. self-sufficiency, remain only marginally economic until the bulk of the natural crude is produced. The only scenario that envisions any reduction in the world oil price is one in which the oil cartel is broken by a U.S. policy encouraging individual OPEC Nations to chisel on prices. The alternative is to either reduce costs by providing greater domestic supply or reduce dependence on oil and its expense by developing large alternative sources of energy. Even these options are expensive in the short run, with medium to long-range, not immediate, pay off. Also, the price of alternatives could well be measured against the price of the oil; as witness the rapid increase in price of coal during the embargo. An added inducement to seeking alternatives is that the Energy Department is pushing a substitute plan for Project Independence, Phase Two, to encourage development of alternatives by pushing up gas and oil prices, hold down fuel imports, and spur development of synthetic fuels. The assumption is that by 1985, the cost of imported oil will rise to $25 a barrel, a price high enough to make many known technologies theoretically competitive(59,p.104). This will especially affect the East Coast since it relies extensively upon imports for No. 2 heating oil. There is no domestic shortage of the heating oil, but under the provisions of the Merchant Marine Act of 1920, as amended, requiring the sole use of U.S. ships in domestic coastal shipping, the No. 2 heating oil that is available on the Gulf Coast must be shipped in American vessels. However, there are few of these vessels available and those which are have charged an exorbitant price(40,p.164). Yet, even without a domestic shortage, 75 percent of the rise in the price of No. 2 heating oil since 1950 occurred after the embargo.

Earlier in the paper, alternatives were discussed. Typical project times, from go-ahead to production, of standard sources of energy are shown in Table 9(55,p.13).

Table 9

Projected Times Required to Complete Facilities
for Standard Sources of Energy

Type of Facilities	Years to Complete
Coal-Fired Plant	8
Surface Coal Mine	4
Underground Coal Mine	5
Uranium Exploration and Mine	10
Nuclear Power Plant	10
Hydroelectric Power Plant	8
Produce Oil and Gas from New Fields	10
Produce Oil and Gas from Old Fields	3

Anticipated time frames for major contributions from other sources of energy are shown in Table 10.

Table 10

Anticipated Time Frame for Alternative Energy Sources to Effect Major Contributions To United States Energy Requirements

Energy Source	Time Frame
Geothermal	post 1990
Synthetic Fuels	post 1990
Fuel Cells	2000
Hydrogen Fusion	post 2000
Solar*	2020
Nuclear	post 2020

*Currently available for space heating, cooling and water heating.

It is obvious from the above tables that production of energy from new or alternative sources will not occur in time to avoid an energy shortage. Fuel prices will obviously rise drastically in face of the increased demand.

OIL INDUSTRY INVESTMENT IN ALTERNATIVES

One of the problems with substituting alternative sources of energy for oil is the rapid growth in the field by the oil industry itself. Although in testimony before Congress and in the trade publications, oil companies insist that their share of the market is small and that they are less concentrated than the U.S. manufacturing average, their share of the total energy market has been increasing rapidly. As Representative Mazzoli of Kentucky asked William T. Slick, Senior Vice President of Exxon, who had made the statement before the Sub-Committee on Monopolies and Commercial Law that the price of a barrel of oil ought to be established by the market place(20,p.1042),

> "What happens if you fellows own the uranium, you own the coal, and you own the oil? You are into solar research heavily; you own whatever there is to own there, including the panel producing plants. And if your philosophy is that you are going to set the price of this based upon what the market will bear and not upon the cost of production, then, where do the people fit in?"

Although the scenario was hypothetical, diversification in the energy industries is prevalent. This may be seen in the diversification in energy resources of the top 18 oil companies as shown in Table 11(20,p.296;58,pp.364-384).

Table 11

Oil Industry Diversification in the Energy Industry
18 Largest Oil Companies

Company	Energy Area						
	Natural Gas	Oil Shale	Coal	Uranium	Tar Sands	Solar	Geothermal
Exxon	X	X	X	X	X	X	
Texaco	X	X	X	X	X		
Mobil	X	X	X	X		X	X
Gulf	X	X	X	X	X	X	X
Standard Oil (Cal.)	X	X			X		X
Standard Oil (Ind.)	X	X		X	X		
Shell	X	X	X	X	X		X
Atlantic Richfield	X	X	X	X	X		
Continental Oil	X	X	X	X	X		
Phillips Petroleum	X	X	X	X			X
Sun Oil	X	X	X	X	X		X
Union Oil	X	X	X	X			X
Cities Service	X	X		X	X		
Getty	X	X		X			X
Standard Oil (Ohio)	X		X	X			
Marathon	X	X	X	X			
Ashland	X	X	X	X			
Amerada Hess	X			X			

The oil industry's and the Nation's leading producer of U_3O_8 (uranium oxide) concentrate, Kerr-McGee, does not appear on the above list because it ranks 25th in size. It also reportedly ranks tenth among U.S. coal reserve holders. Continental oil ranks first in U.S. coal reserve holdings and ranked second in coal production in 1975.

ENERGY CONSUMPTION IN THE SCHOOL BUILDING

Most of the available data on energy consumption in schools are aggregated within commercial or residential/commercial figures. Energy consumption by the schools is three percent of the nation's total and is included as part of the 13 percent nationwide figure for commercial consumption according to the official FEA figures. In 1975, the public schools in New York State consumed approximately 1¼ percent of the fuel oil used in the State, about one percent of the natural gas, and about 2½ percent of the electric sales(32). National and New York State sector breakouts are slightly different, but the energy consumption figures, including schools, are compared in Table 12(38,App.A,Table 14; 50; 70).

Table 12

U.S. and N.Y.S. Percentage Comparison of
Energy Consumption by Sector
(Rounded to nearest percent)

U.S. CONSUMPTION		NEW YORK STATE CONSUMPTION	
Sector	% of Energy Usage	Sector	% of Energy Usage
Industrial	43%	Industry	10% } 40%
Residential	19% } 32%	Electric Utilities	30% }
Commercial	13% }	Residential/	
(Schools)	(3%)	Commercial	34%
Transportation	24%	(Schools)	(1-2½%)
		Transportation	26%

Heating Costs

Except for electric utilities, the energy consumption figures for all sectors of the economy have declined since 1970. The New York State Department of Public Service reports that New York State energy consumption peaked in 1970, was on a plateau between 1970 and 1973, and was predicted to decline after 1973(37,p.45). The projected trend was correct, but the magnitude of change was underestimated. For our Nation's schools, the energy cost per student rose from $20 in 1973 to $46 in 1977 while overall energy consumption has dropped less than five percent. It is predicted that the cost per student will increase to $57 in the 1978-79 school year (66). New York State is colder than the nation as a whole, having an average of 6,500 heating degree days. In the New York/New Jersey region, the average per pupil energy cost rose from $28.06 in school years 1972-73 to $48.04 by school years 1974-75. The overall fuel cost per pupil rose 71.2 percent, while that of oil rose 126 percent in spite of a 15 percent drop in consumption(72,p.34). The median fuel cost per thousand square feet during the same period rose 66.2 percent, from $266.29 per thousand square feet to $442.66(72,p.35) as opposed to a national rise of 39.8 percent during the same period, from $204.50 per thousand square feet to $286.04. The greatest increase in per pupil energy cost is in oil, and it is our most prevalent energy source. Comparisons of percentage of usage are expressed in Table 13(77,p.2).

Table 13

Comparative Percentages of Energy Usage
by Source of Energy
New York State—Middle Atlantic States—United States

	ENERGY SOURCE				
Area	Oil	Natural Gas	Coal	Electricity	Others
N. Y. State	59%	16%	5%	20%	Negligible
Mid-Atlantic	45	28	7	18	2%
United States	24	48	7	19	2

New York State is well above the national average in degree days, and also well above the national average in uses of the most expensive energy source for our schools. The increased energy cost in the New York/New Jersey region from school year 1972-73, before the oil embargo, to the school year 1974-75, after the embargo, was the cost equivalent of 8,300 teacher positions. Table 14 shows the preliminary figures for energy conservation savings in New York State schools in 1975-76 compared with 1972-73(7,p.30).

Table 14

Comparative Percent Reduction
in Energy Usage
in New York State Schools
Between 1972-73 and 1975-76

Energy Source	% of Reduction in Usage
Fuel Oil	13
Coal	23
Natural Gas	21
Electricity	18

These percentages are well in excess of the figures that could be attributed to either declining enrollment or the closing of school buildings.

During the reporting period, the New York/New Jersey region had the highest per pupil expenditures for fuel in the Nation, and its percentage of increase was exceeded only by New England. The figures also hold true for median energy cost per 1,000 square feet. The influence of size of school district may be seen in Table 15(74,TablesII-III).

Table 15

Comparative Per Pupil and Per 1000 Square Feet Fuel Costs
for Schools in the New York/New Jersey Region
School Year 1972-73 and 1974-75

Size of School District By Enrollment	COST PER PUPIL			COST PER 1000 SQUARE FEET		
	School Year			School Year		
	1972-73	1974-75	% Change	1972-73	1974-75	% Change
Over 25,000	$17.51	$26.78	52.9	$177.43	$206.11	46.6
10,000-24,999	20.58	28.84	40.1	219.07	304.44	38.9
5,000- 9,999	18.72	30.98	65.4	216.83	326.62	50.6
2,500- 4,999	21.02	34.02	61.7	201.18	317.01	57.5
1,000- 2,499	19.98	28.09	40.5	188.81	251.65	33.2
Under 1,000	22.83	32.88	44.0	201.65	256.85	27.3

Nationwide, in the 1974-75 school year, 2.84 percent of the median school budget and 12.5 percent of the current expenses went for energy(55,p.19). The districts experiencing the lowest fuel cost increases were those dependent upon natural gas. However, for some of the districts, obtaining sufficient fuel was a problem. Although salaries have been the major cause of increases in school budgets, the price of heat and other utilities has caused the school's maintenance and operations budgets to rise faster than the general budget.

The energy lost in school buildings is large, estimated to be from 25 to 50 percent of the energy used(73,p.5) and in selected instances, even more. In line with this, Educational Facilities Laboratories (EFL) have predicted that the Nation's public schools will waste about $740 million on energy in the 1978-79 school year (66). This consumption could be reduced 20 to 50 percent by implementing conservation methods and another 20 percent by making modifications in buildings. EFL conducted a weighted sampling of 766 elementary schools and found that energy savings were possible in most of them. However, improvement in operating efficiency was constrained in most schools because of: insufficient administrative initiative for energy conservation, a shortage of trained personnel to operate complex equipment, lack of funds for proper maintenance, and/or a tendency to purchase equipment that has low first cost but is expensive to operate.

In the near term, retrofitting, insulation, heat pumps, and total energy systems coupled with design improvement in buildings appear to offer the biggest energy savings. Schools which have depended upon electricity have done best during the energy crisis because the schools were well constructed and better insulated in order not to lose the value of an expensive energy source. This is in opposition to those schools that were constructed without concern for losing the value of the then inexpensive fossil fuel energy. For these electrical schools, long-term savings were considered more important than construction cost savings.

The most significant new technology being developed for saving conventional energy resources in buildings is solar heating and cooling. Schools near Boston; Atlanta; Baltimore; Washington, D.C.; and Osseo, Minnesota are using solar units to provide classroom heat(55,p.77). In suburban Washington, D.C., an 8,000 square foot school was designed using a 4,000 square foot solar collector. Perhaps the most successful of the National Science Foundation funded solar projects to date is the George A. Towne Elementary School, Atlanta, Georgia. The solar system provides about 60 percent of the school's heating and cooling requirements and up to 80 percent of the domestic hot water.

National projections for use of energy in the household and commercial sectors, published by the Bureau of Mines, are for significant changes in source of energy. Coal is expected to lose virtually all its share of the market and the petroleum and gas share will also decline. The most significant increase will occur in electrical energy consumption. The residential/commercial sector is, thus, expected to turn more and more to electricity in the future. Projections of energy consumption show net reductions. However, if the total energy required to produce the net energy in the form of electricity used by the sector is taken into consideration, the residential/commercial share of the national energy usage remains constant(15,p.48). About two-thirds of the energy value of a source of energy is lost when it is converted into electricity. The portion of the President's energy program relating to energy

conservation in the schools is geared toward reducing oil and electricity usage in buildings in order to save on direct usage of oil as well as on oil used to generate electricity. Therefore, in general, any advantages of alternative sources of energy to the schools would be indirect through their use to generate the electricity the schools use and the greater availability of oil to the schools because of other sectors of the economy using alternative sources of energy instead of oil.

Effect of Calendar Options on Total Energy Consumption

Two calendar alternatives available to schools for conserving energy involve either closing schools during the winter, or remaining open year round. A study of the effects of changing school building operation was conducted at the request of the Colorado Department of Education. The Colorado study showed that closing schools in the winter would save energy for the school district. However, a study conducted by the North Carolina Department of Education, Division of Plant Operation estimated an increase in total fuel consumption because of the increase in fuel consumption in the residential sector when the students were out of school(55,p.26). Nation-wide the amount of fuel saved by emergency closing of schools was disappointing because sufficient heat had to be maintained in order to avoid structural damage and/or expensive shutdown and reopening procedures(9,p.II-9). Twenty-four school districts that were closed down during a two-week gas shortage by the Dayton Power and Light Company in the winter of 1976-77 accounted for one percent of the utility's total consumption (which is the same as New York State's figure) and a complete shut down of all southern Ohio schools would have saved the company "about a day's fuel" (13, p. 5).

Year-round schools bring into consideration the cost of air conditioning. Earlier studies showed that air conditioned schools were less expensive to build, operate, and maintain than conventional schools. This assumed life-cycling cost. It cannot be presumed that to air condition existing schools for year round schooling, in order to conserve energy during winter months, would be an inexpensive solution. In a simulation study done in Colorado, if air conditioning were used during the normal school year in an existing test building, without improving the building insulation, it would have added 16.4 percent to the annual electrical consumption of the building. If the building were used for summer school, the electrical consumption would have increased by 61.2 percent(11,p.6). In Eagle, Colorado, which has a relatively high elevation and cool climate, the effect of sun and light on the building plus children in the classroom contributed to the increase in energy consumption during the air conditioning season. Also, the study showed that the use of air conditioning increased the annual cost of heating by 1.9 percent in a nine-month school year and 4.6 percent in a year-round school. This is because, in a non-air conditioned building, the heat generated during the day remains through the night and will compensate for any night-chill. In the air conditioned building, the maintenance of temperature at 72 or 75 degrees does not allow exclusive heat build-up, and any night-chill will activate the heating system.

In a comparative study of year-round and traditional use of buildings in Jefferson County, Colorado, the average electrical consumption in the air conditioned, year-round school was 42 percent higher on a square foot basis and 22 percent higher on a per pupil basis than in the average of the traditional schools in the study. This higher cost for the air conditioned schools held constant when comparing

the high, the low, and the average per pupil operating costs for the year-round schools as compared with the schools following the traditional calendar (60, p. 4). In the air conditoned, year round school the average fuel consumption was 4 percent higher on a square foot basis, but 11 percent lower on a per pupil basis, than in the average of the traditional schools in the study. In the comparison of the low energy cost schools, the traditional school consumption was 11 percent less than the year-round school on a per pupil basis and 18 percent less on a square foot basis. In the comparison of the high energy cost schools, the traditional school consumption was 84 percent more than the year-round school on a per pupil basis and 83 percent more on a square foot basis (60, p. 6). In the last case, it should be noted that this school's energy cost figures differed from the costs of the traditional school average by about the same magnitude. This study reinforces the findings of greater costs in electricity and heating in the year-round school because of the air conditioning.

In sum, winter closings save energy for schools, but not as much as might be expected. Also, unless a school building is specifically constructed as an air conditioned school, the costs of conducting school in the summer will exceed any savings from winter closing.

BIBLIOGRAPHY

1. Alexander, G., "Harnessing The Fires Below," National Wildlife, 14 (January 1976), 36-39.

2. "American Energy Crisis," Town and Country Planning, 45 (June 1977), 328-331.

3. "American Energy: One Policy is Enough," Economist, 262 (5 February 1977), 82-83.

4. American Petroleum Institute, Facts about Oil, (Washington, D.C.: November 1977).

5. Anderson, B., "Sun in a Drawer; No Shadows Allowed," Environment, 17 (October 1975) 36-38+.

6. Bohi, Douglas R. and Milton Russell, U.S. Energy Policy: Alternatives for Security, (Baltimore: Johns Hopkins University Press, 1975).

7. Bowen, Jeffrey M., "Some Questions and Answers on Educational Costs and Comparisons," Journal of the New York State School Board Association, Inc., (September 1977), 29-30.

8. Carey, Hugh L., Governor, Special Message to the Legislature of the State of New York with Regard to Energy, (8 February 1978).

9. Carnegie-Mellon Institute of Research, Regional Energy Policy Alternatives: A Study of the Allegheny County Region. Final Draft Report--Phase I, (Pittsburgh: 10 October 1977).

10. "Coal Option: General Accounting Office Report," Scientific American, 238 (January 1978), 64.

11. Colorado Department of Education, Supporting Services Unit; Energy Usage: A Computer Report on the School Day, School Calendar, Night Set-Back, and Year-Round Schools, (Denver, Co.: June 1974).

12. Committee for Economic Development, Key Elements of a National Energy Strategy, (New York: Georgian Press, June 1977).

13. "Conference Debates School Role in Energy Crisis," Report of Education Research, 13 (July 1977), p. 5.

14. Crump, Leslie H., Fuels and Energy Data: United States by States and Census Divisions, 1974, (Washington, D.C.: Bureau of Mines, U. S. Department of the Interior, 1977).

15. Dupree, Walter G. and John S. Corsentino, United States Energy Through the Year 2000 (Revised), (Washington, D.C.: Bureau of Mines, U.S. Department of the Interior, December 1975).

16. Economic Impact of President Carter's Energy Program, Hearing before the Senate Committee on Natural Resources, 95th Congress, 1st Session, (3 May 1977).

17. The Economics of the President's Proposed Energy Policies, Hearings Before the Joint Economic Committee, 95th Congress, 1st Session, (20 and 25 May 1977).

18. Edison Electric Institute, Economic Growth in the Future: The Growth Debate In National and Global Perspective, (New York: McGraw-Hill, 1976).

19. "Energy Crisis: Special Report," Nations Schools, 93 (January 1974), 31-54.

20. Energy Industry Investigation, Hearings Before the Subcommittee on Monopolies and Commercial Law of the House Committee on the Judiciary, 94th Congress, 1st and 2nd Sessions. (30 July, 4 September 1975, 11, 19, 25 February, 3 March and 14 April 1976), Part I.

—(31 July, 10 and 11 September 1975), Part 2.

21. Executive Office of the President, The National Energy Plan, (Washington, D.C.: 29 April 1977).

22. Executive Office of the President, National Energy Plan Oil & Gas Supply, (Washington, D.C.: 15 July 1977).

23. Executive Office of the President, Replacing Oil and Gas with Coal and Other Fuels in the Industrial and Utility Sectors, (Washington, D.C.: 2 June 1977).

24. Exxon, World Energy Outlook, Exxon Background Series, (April 1978).

25. Exxon USA, (Second Quarter 1977).

26. Federal Energy Administration, Energy in Focus: Basic Data, (Washington, D.C.: May 1977).

27. Federal Energy Administration, 1976 National Energy Outlook Executive Summary, (Washington, D.C.: 1976).

28. Federal Energy Administration, Project Independence Report, (Washington, D.C.: November 1974).

29. Flower, Andrew R. "World Oil Production," Scientific American, 238 (March 1978), 42-49.

30. "Four Ways to Get Ready for the Big Energy Troubles that Loom for Schools," American School Board Journal, 164 (25 January 1977), 32-33.

31. "Geographical Magazine World Map of the Energy Market: Top Ten in Power Reserves," Geographical Magazine, 46 (May 1974), 408.

32. Geopolitics of Energy, Energy Publication 95-1, Committee Print of the Senate Committee on Interior and Insular Affairs, 95th Congress, 1st Session (January 1977).

33. Graubard, Stephen R., (ed). "The Oil Crisis: In Perspective," Daedalus, 104 (Fall 1975).

34. Hall, Robert E. and Robert S. Pindyck, "The Conflicting Goals of National Energy Policy," The Public Interest, No. 47 (Spring 1977), 3-15.

35. Hanson, J.K., "Energy from Biomass: Using Organic Junk for Energy," Current 190 (February 1977), 39-42.

36. Harvey, Andrew C., Consumption of Energy in New York State: 1974, O.R. Report No. A-2 (Albany, New York: New York State Department of Public Service, February 1976).

37. Harvey, Andrew C., Consumption of Energy in New York State; 1975, O.R. Report No. B-2 (Albany, New York: New York State Department of Public Service, April 1977).

38. Hausgaard, Olaf, An Energy Almanac, New York State: 1960-1980, O.R. Report No. A-3 (Albany, New York: New York State Department of Public Service, June 1976).

39. Hausgaard, Olaf, Andrew C. Harvey, and Nancy Rockenstyre, Utility Statistics Handbook: 1976, O.R. Report No. B-3 (Albany, New York: New York State Department of Public Service, November 1977).

40. Home Heating Oil., Hearing Before the Senate Committee on Interior and Insular Affairs, 95th Congress, 1st Session, (10 February 1977).

41. Impact of the National Energy Plan, Hearings Before the Senate Committee on Energy and Natural Resources, 95th Congress, 1st Session, (19 May 1977).

42. Impact of the President's Energy Plan on the Northeast. Hearings Before the Subcommittee on Energy of the Joint Economical Committee, 95h Congress, 1st Session, (13 May 1977).

43. Industrial Bank of Japan, Japanese Finance and Industry, Quarterly Survey, No. 36, (Tokyo: October-December 1977).

44. Kasper, William and David P. Stricos, Effect of the President's Oil Tax Proposals on New York State Utility Fuel Costs, O.R. Report 75-7 (Albany, New York: New York State Department of Public Service, June 1975).

45. Lawrence, Robert M. and Norman I. Wengert (eds), "The Energy Crisis: Reality or Myth," Annals of the American Academy of Political and Social Science, 410 (November 1973).

46. Lippincott, W.T., "Energy: World Needs and Reserves," Journal of Chemical Education, 51 (February 1974), 71.

47. "Looking Ahead at Energy," The Lamp, (Spring 1978) i-1.

48. Lovings, A.B., "Energy Strategy: The Road Not Taken?," Foreign Affairs, 55 (October 1976), 65-96. Rejoinder by B. Wolfe 55 (July 1977), 891-900.

49. Massachusetts Department of Education, Energy Conservation in Existing School Facilities: An Overview, (Boston: 1975).

50. Miller, Robert, Senior Architect, Division of Educational Facilitites Planning, New York State Education Department, Memo of 25 August 1977.

51. Morris, R., "Whatever Happened to the Natural Gas Crisis?," Columbia Journalism Review, 14 (March 1976), 32-34+.

52. Murphy, Michael J., "America's Current Energy Situation," Ninth District Quarterly, Federal Reserve Bank of Minneapolis, 3 (October 1976), 8-16.

53. Natural Gas Pricing Proposals: A Comparative Analysis. Committee Print of the Senate Committee on Energy and Natural Resources, 95th Congress, 1st Session, (September 1977).

54. "Natural Gas, Unnatural Prices," Economist, 42 (9 August 1975), 42.

55. Neill, Shirley Boes, School Energy Crisis; Problems and Solutions, (Sacramento, CA.: American Association of School Administrators, 1977).

56. New York State Emergency Energy Plan, New York State Energy Office, (Albany, New York: January 1978).

57. Palmedo, Philip F., "Approaches to Regional Energy Analysis," Growth and Change, 7 (October 1976), 25-32.

58. Petroleum Industry Involvement in Alternative Sources of Energy, Publication No. 95-54, Committee Print of the Senate Committee on Energy and Natural Resources, 95th Congress, 1st Session, (September 1977).

59. "Phase Two Meets Its Critics," Business Week, No. 2531, (24 April 1978), 104.

60. Price, Waterhouse & Co., Jefferson County School District No. R-1 Report on the Economic Evaluation Study of Concept 6, (Denver, Co.; 24 November 1976).

61. "Problem of Exhaustible Resources," National Review, 29 (25 November 1977), 1352-1353+.

62. Project Interdependence: U.S. and World Energy Outlook Through 1990. Committee Print of the House Committee on Interstate and Foreign Commerce and the Senate Committee on Energy and Natural Resources and Committee on Commerce, Science, and Transportation, 95th Congress, 1st Session, (November 1977).

63. Projects to Expand Fuel Resources in Eastern States: Survey of Planned or Proposed Coal Mines, Coal and Noncoal Conversion Plants, Electric Generating Plants, Oil Refineries, Uranium Enrichment Facilitites, and Related Intrastructure In States East of the Mississippi (As of June 1976), (Washington, D.C., Bureau of Mines, U.S. Department of the Interior, 1976).

64. Quigley, Carroll, "America's Future in Energy," Current History, 69 (July/August 1975), 1-5+.

65. Regulation of Domestic Crude Oil Prices, Committee Print of the Senate Committee on Energy and Natural Resources, 95th Congress, 1st Session, (March 1977).

66. "School Energy Waste Predicted at $740 Million This Year," Report on Education Research, 10 (23 August 1978), 2.

67. "Scorecard on Energy," Duns Review, 109 (June 1977), 54-57.

68. Shapiro, H., "Economics of Energy," Environment, 19 (January 1977), 37-38.

69. Sharbaugh, H. Robert, "Petroleum and Energy," Annals of the American Academy of Political and Social Science, 420 (July 1975), 86-97.

70. Stephan, Edward, Director, Institutional Buildings Progams, Energy Conservation and Environment, Federal Energy Administration, Undated Memo.

71. Stephan, Edward, "Energy Management," American School and University, 48 (April 1975), 33-35.

72. Stephan, Edward, "Impact of Rising Fuel Costs," American School and University, 49 (December 1976), 34-35+.

73. Stephan, Edward, Proposed FEA Position Paper, Public Schools, Colleges and Universities, (Washington, D.C.: Institutional Buildings Programs, Federal Energy Administration, Draft Dated 27 August 1975).

74. Stephan, Edward, A Report to Survey Participants, (Washington, D.C.: Institutional Buildings Programs, Federal Energy Administration, n.d.).

75. "Symposium on Analytical Models of Energy Policy," The Bell Journal of Economics and Management Science, 5 (Autumn 1974), 459-592.

76. U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, (Washington, D.C.: January 1978).

77. University of the State of New York, The State Education Department, School Facilities Planning and Management News, (Albany, New York: August 1977).

78. Walters, E.A., and E.M. Wewerka, "Overview of the Energy Crisis," Journal of Chemical Education, 52 (May 1975), 282-285.

79. Yang, Jai-Hoon, "The Nature and Origins of the U.S. Energy Crisis," Federal Reserve Bank of St. Louis Review, 59 (July 1977), 2-12.

80. Zimmerman, M.B., "Modeling Depletion in a Mineral Industry: The Case of Coal," Bell Journal of Economics, 8 (Spring 1977), 41-65.

81. Zweifel, P.F. and A. Guynn, "Are There Viable Alternatives to Nuclear Power?," Chemistry, 47 (September 1974), 16-18.